Laid-Open Publication

DE 34 18 361 A1

Device for reducing throttle losses in piston engines with partial loads by means of phase angle control of the valves

In order to improve the economy of piston engines with partial loads, it is proposed to avoid the systematic part of throttle losses during intake and exhausting in that intake takes place without throttling in the intake manifold up to the desired charge, and then the inlet valve is closed, and the outlet valve is only opened at over-expansion when atmosphere pressure is reached again when the piston returns (Fig. 1). With method 2, the inlet valve remains open until, with the piston return, the excess charge is blown out again. For control, a mechanical solution is described with which the valve levers (3) are given profiling (4) so that according to the position of the horizontally movable cam shaft (2), the desired phase angle control is achieved, and secondly, an electronic control with actuation magnets for each valve which also optimizes control points EÖ [inlet opening] and AS [outlet closing]. For method 2, a solution with 2 cam shafts running out of phase is described with the same phase with a full load.

Device for reducing throttle losses in piston engines with partial loads by means of phase angle control of the valves.

Annex 3 to the application Herbert Gohle of 17.5.1984

Patent Claims:

1. A device for reducing throttle losses in piston engines with partial loads, consisting of a valve control with variable control angles, characterized in that the variable control points ES (inlet closure) and AÖ (outlet opening) are adapted by the control actuation according to Claim 2 to the current operational point in such a way that partial charging is achieved, instead of by throttling in the intake manifold, only by premature closure of the inlet valve (method 1), or with method 2 by subsequent exhausting of the excessive charge by closing the inlet valve during the compression stroke, and that over-expansion in the working stroke with a partial charge is made harmless in that the outlet valve is only opened when atmospheric pressure has been reached again in the discharge stroke.

2. Control actuation for the device according to Claim 1, consisting of profiling of the valve levers (recess (4)) which in connection with the transversely movable cam shaft (2) brings about premature (or, with method 2, subsequent) closure or subsequent opening of the valves dependent upon the current position of the cam shaft. Included in this claim is the alternative design for subsequent closure of the inlet valve with method 2 by a 2nd cam shaft (5) which runs out of phase with the 1st (2) (in phase with full loads).

3. The device according to Claim 1, characterized in that all of the control points, i.e. also EÖ (inlet opening) and AS (outlet closure) are optimally chosen according to the current operational point, and that the control actuation is implemented electronically by means of actuation magnets for each valve.

Device for reducing throttle losses in piston engines with partial loads by means of phase angle control of the valves.

Annex 2 to the application Herbert Gohle of 17.5.1984

With piston engines which operate with greatly changing loads (vehicle engines), throttle losses occur with partial loads because intake takes place with a partially closed throttle valve in the intake pipe with low pressure, whereas after the working stroke it must be exhausted against full atmospheric pressure. Throttle losses also occur after the working stroke due to over-expansion if with a small charge, the pressure at the end of the working stroke falls to below the atmosphere line.

The invention presented here avoids the systematic part of these losses in that intake takes place in the intake pipe up to the desired charge without throttling, and then the inlet valve is closed. Equally, with a partial load, and with over-expansion, the outlet is kept closed until atmospheric pressure is reached again with the piston return (see Fig. 1, PV diagram). The negative pressure regions between ES (inlet closure) and AÖ (outlet opening) are harmless however. Instead of a throttle valve in the intake manifold operated by the accelerator pedal, a control for the closure point actuated by the accelerator pedal for the inlet valve and of the opening point for the outlet valve must be incorporated here. The advantage with respect to the usual intake throttling is the avoidance of the troublesome low intake pressures and the possibly occurring over-expansion with partial loads and the energy lost in this way, which can only be used for braking. Closure of the inlet valve during the outward movement of the piston with a large air movement causes much lower friction losses however. As a variation of this idea (method 2), it is also possible to always take in a full charge, to blow excessive charge out again with the piston return (in the compression stroke), and only then to close the inlet. Unlike the 1st method, greater losses occur here, but these can possibly be countered by other advantages – better mixture formation, cooling -.

In particular due to the high possible compression ratio when using spring mounted pistons (my application No. P 34 14 041.7 of 13.4.84), engines which are sure to be very economical with partial loads can in this way be built. These considerations apply to Otto and Diesel engines in the same way. With Otto engines a mixture can be taken in, and with method 2, with a partial load it can be conveyed back again into the intake manifolds, the mixture formation being very intensive, or the fuel being injected directly into the cylinder as with diesel engines.

The phase angle control of the inlet valve (or the inlet valves) (1) happens e.g. according to Fig. 2 by means of a correspondingly formed swing arm (3) over which the cam shaft (2) is disposed movably according to the accelerator pedal position. With a full load the cam shaft is on the right and has normal function. With a partial load it is further to the left, and the cam slides into the recess (4) in the swing arm so that the inlet closes prematurely. The cam shaft can be displaced by known possibilities which are not the direct object of this application, e.g. by means of the worm drive shown in Fig. 2, by means of which a slide, on which the cam shaft is mounted, is moved.
The control of the outlet valve (6) with a closure angle which becomes greater with a partial load – or also with method 2 of the inlet valve (1) with an opening angle which becomes greater – is implemented by means of a similar arrangement (Fig. 3). The opening angle of the inlet valve which becomes greater can be better controlled by a 2nd cam shaft (5) such as in Fig. 4 which according to the accelerator pedal position runs out of phase with respect to the 1st (normal (2)). Both shafts can act upon one or also upon 2 different valves if 2 inlet valves are incorporated for each cylinder. With a full load, both cam shafts run in phase. With a full load, the 2nd cam shaft (5) is out of phase with respect to the 1st such that the point ES, in accordance with the accelerator pedal position, is shifted into the compression stroke, whereas the 1st cam shaft (2) controls the opening point (EÖ) of the inlet valve which is in all cases dependent upon the number of revolutions. This phase control is brought about by a gearing mechanism which is not the direct object of this application. Known forms of gearing mechanism can be used for this, e.g. the very simple

worm gear shown in Fig. 5, or another possible form. Electronic control is also conceivable with actuation magnets for each valve, and this has the further advantage that all of the control points can be chosen optimally in accordance with the current operational data.

Patent Claims

Sheet of Figures:

<u>Annex 4</u> to the application Herbert Gohle of 17.5.1984
Device for reducing throttle losses in piston engines with partial loads by means of phase angle control of the valves

<u>Fig. 1: PV diagram</u>

Vollast normal = full load normal
bei großer Verdichtung mit Federkolben (schematisch)
= at great compression with spring piston (schematic)
bei Teillast mit großer Verdichtung
= at partial load with great compression

<u>Fig. 2a Inlet valve</u>

Nockenwelle verschieblich
= cam shaft movable
bei Teillast = at partial load
Vollaststellung = full load position
Schwingarm = swing arm
Ausnehmung (Profilierung)
= recess (profiling)
Einlaßventil = inlet valve

<u>Fig. 2b Spindle drive for displacing the cam shaft</u> on a slide

Mutter = nut
Lager = bearing
Spindel = spindle
Schlitten = slide
Zylinderkopf = cylinder head
Antrieb = drive or actuation
Gaspedal = accelerator pedal

Fig. 3 Outlet valve

Nockenwelle verschieblich	=	cam shaft movable
Vollast	=	full load
Teillast	=	partial load
Ausnehmung	=	recess
Schwinghebel	=	swing arm [or lever]
Auslaßventil	=	outlet valve

Fig. 4 Arrangement of 2 cam shafts for controlling the inlet valve with method 2

1. Nockenw.	=	1st cam shaft
2. Nockenw.	=	2nd cam shaft
phasenverschoben	=	phase shifted
Schwinghebel	=	swing arm
hier auf 1 Ventil wirkend dargestellt	=	here shown as acting on 1 valve

Fig. 5 Worm gear (schematic) for phase control of the 2nd cam shaft

Zahnriemenscheibe o.ä., hier zur Vereinfachung fliegend auf der Welle dargestellt	=	drive belt pulley or the like, here for the sake of simplicity, shown overhung on the shaft
Lager (schematisch)	=	bearing (schematic)
Drucklager (schematisch)	=	thrust bearing (schematic)
2. Nockenwelle	=	2nd cam shaft
Antrieb vom Gaspedal	=	drive or actuation by the accelerator pedal
Schnecke	=	worm gear